



# A Novel Concept to Explore the Coupling of the Solar- Terrestrial System

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and a host of contributors

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*2014 Chapman Conference on Magnetosphere-  
Ionosphere Coupling in the Solar System*

The novel concept is called the  
Geospace Dynamics  
Observatory  
GDO  
!

# Geospace Dynamics Observatory

The Geospace Dynamics Observatory (GDO) mission observes the near-Earth region in space called Geospace with unprecedented resolution, scale and sensitivity. At a distance of 60 Earth Radii (Re) in a near-polar circular orbit and a ~27-day period, GDO images the earth's full disk with (1) a three-channel far ultraviolet imager, (2) an extreme ultraviolet imager of the plasmasphere, and (3) a spectrometer in the near to far ultraviolet range that probes any portion of the disk and simultaneously observes the limb.

# summary

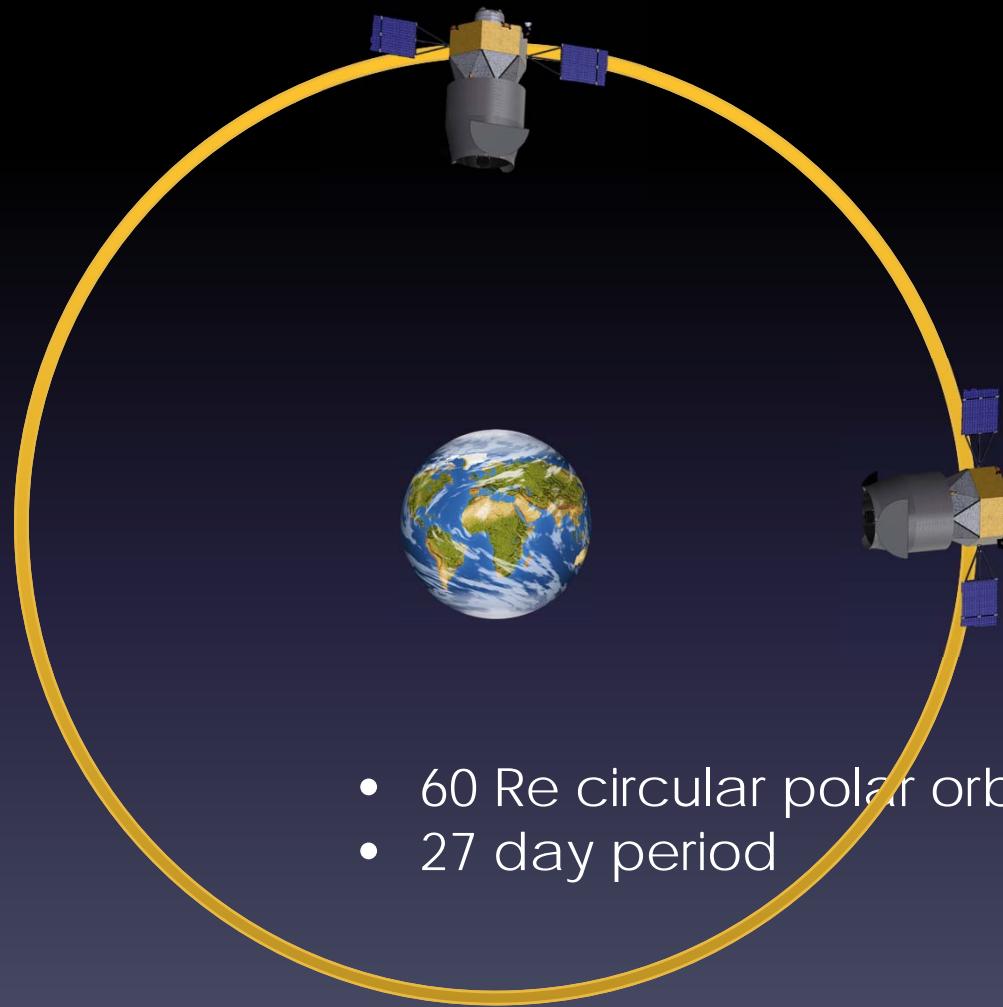
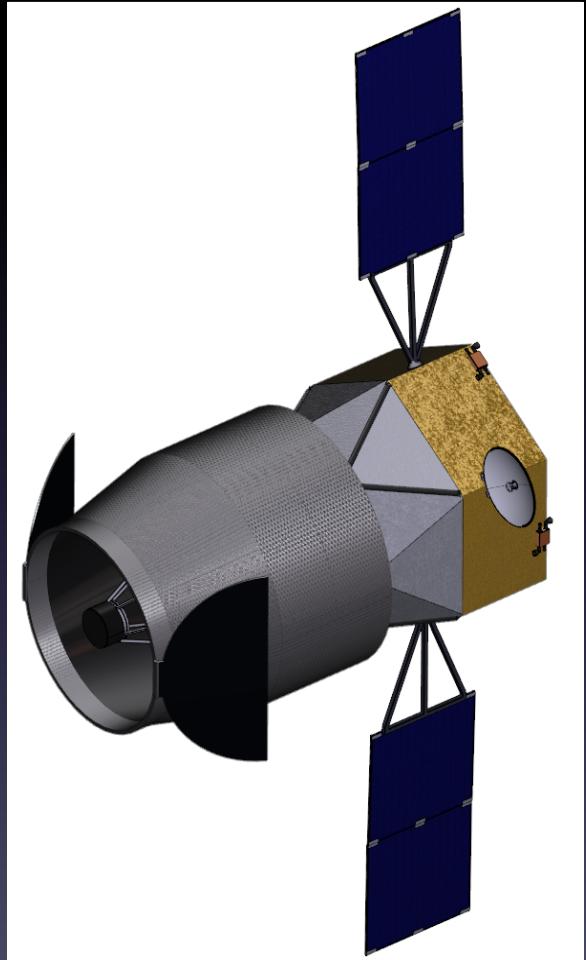
*Science advancement beyond measure*

- Will provide a key link to understand the coupled Sun-Earth system
- Will open a window to discovery that will revolutionize our view of near-Earth space
- Fills gaps enabling space weather advancement
- Consistent with the 2012 Heliophysics Decadal Survey emphasis to investigate the coupled magnetosphere/ionosphere/mesosphere/stratosphere system

*Observatory Class facility*

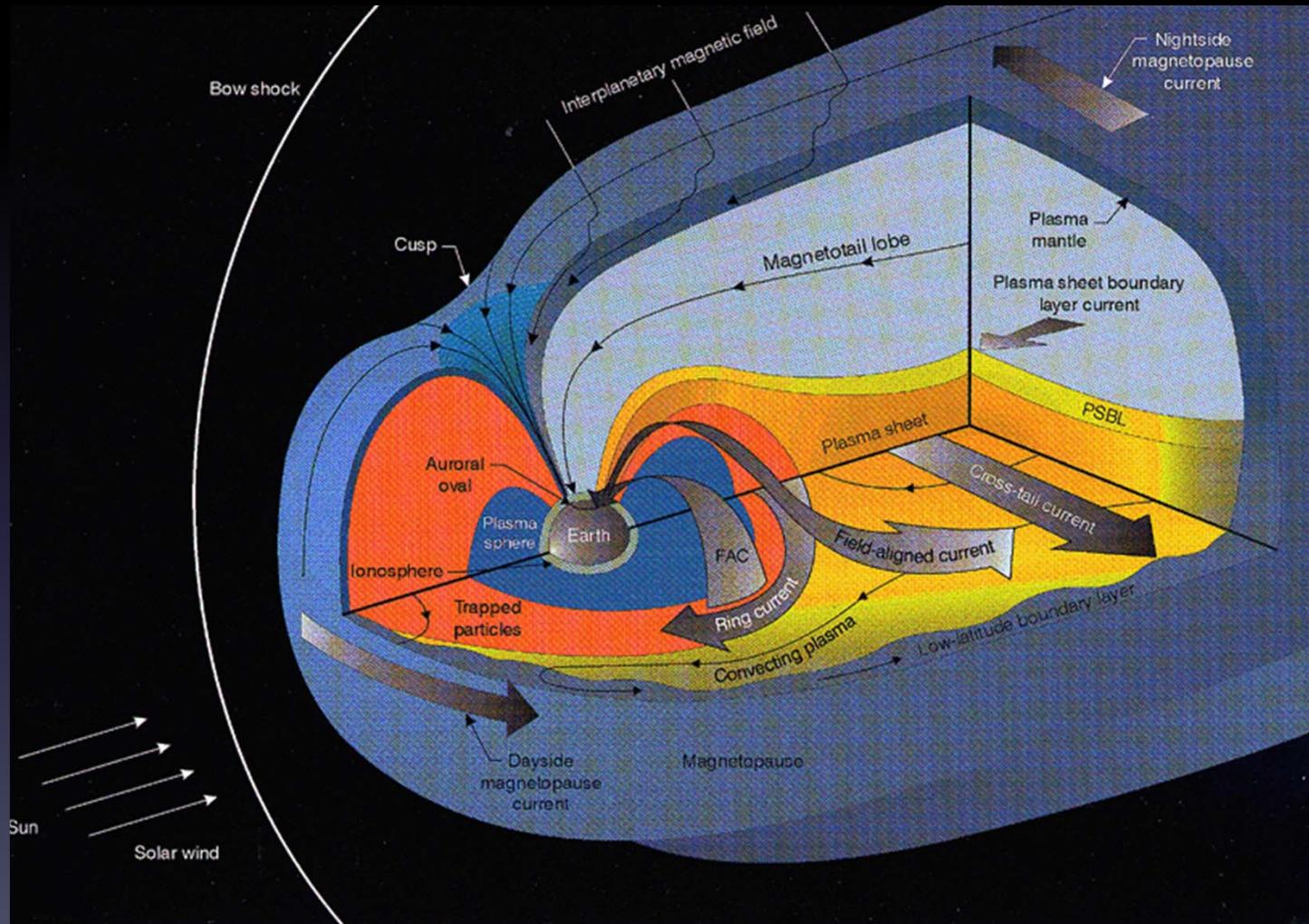
- New for solar and space physics

# mission concept

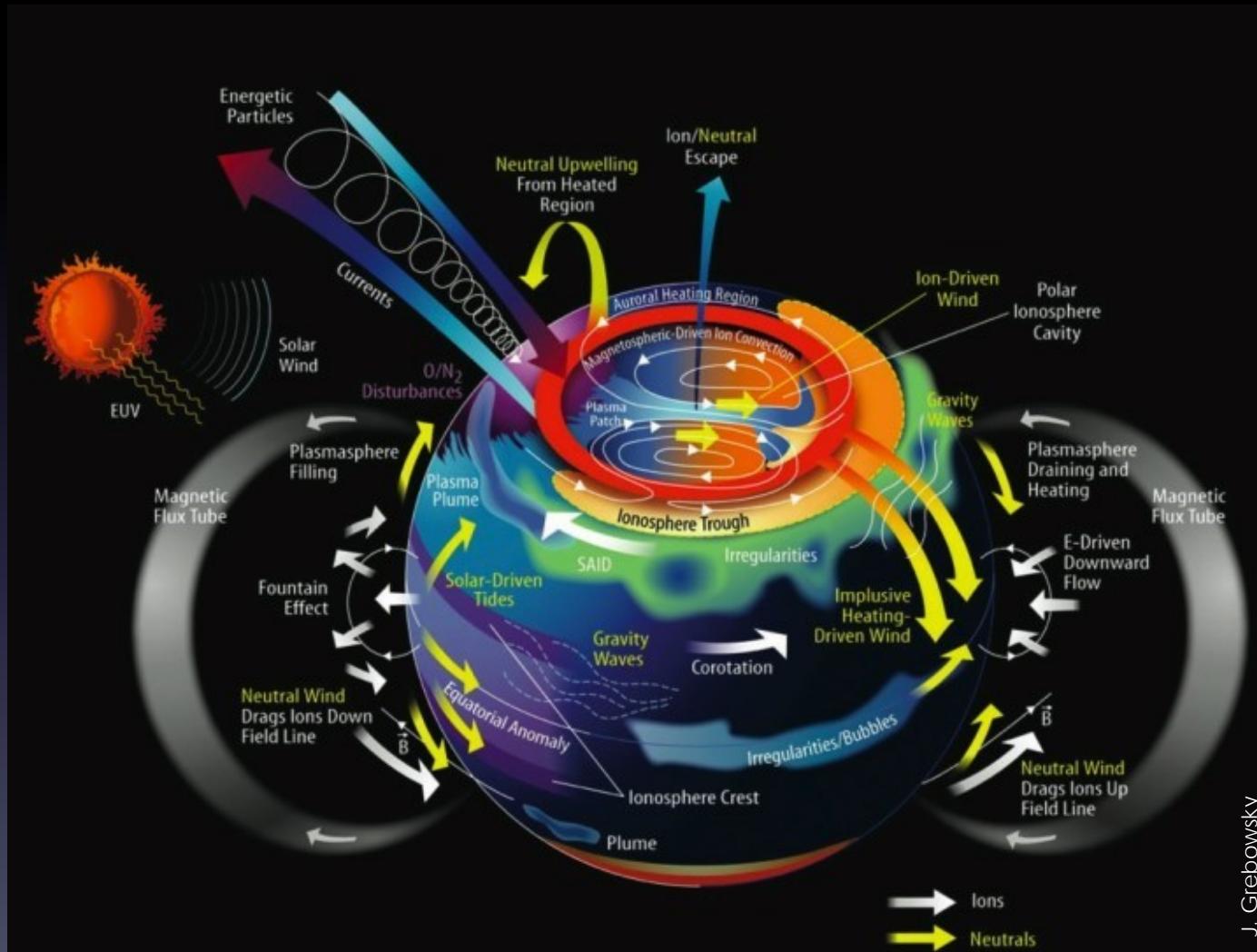


- 60 Re circular polar orbit
- 27 day period

# Geospace



# Earth's interface with space



# examples of revolutionary scientific advances enabled by GDO

- *Unparalleled advances in the connection of the upper atmosphere to the Sun.*
  - In the aurora and lower latitudes, extending the duration of uninterrupted images provides advances in understanding of the transfer energy from the Sun to the upper atmosphere and in the response of the space environment.
- *Advances in the influence of waves and tides on the upper atmosphere.*
  - Increasing both the signal to noise and the duration of the observations reveals contributions that are not identifiable using other approaches.
- *The ability to probe the mechanisms that control the evolution of planetary atmospheres.*
  - The vantage point provided by GDO allows the flux of hydrogen and oxygen (which is tied to the escape of water from a planet) to be mapped globally. It provides new observations of changes in the atmospheric structure and their causes.

# GDO mission concept

- The Geospace Dynamics Observatory (GDO) mission observes Geospace with unprecedented resolution, scale and sensitivity.
- In a near-polar circular orbit at the lunar distance (60 Re and ~27-day period), GDO images the near-earth region with
  - three far ultraviolet, co-aligned simultaneous imagers
  - an extreme ultraviolet wide field-of-view imager of the plasmasphere
  - a spectrometer in the near to far ultraviolet range that will probe any portion of the disk and simultaneously observe the limb.

# state of the art

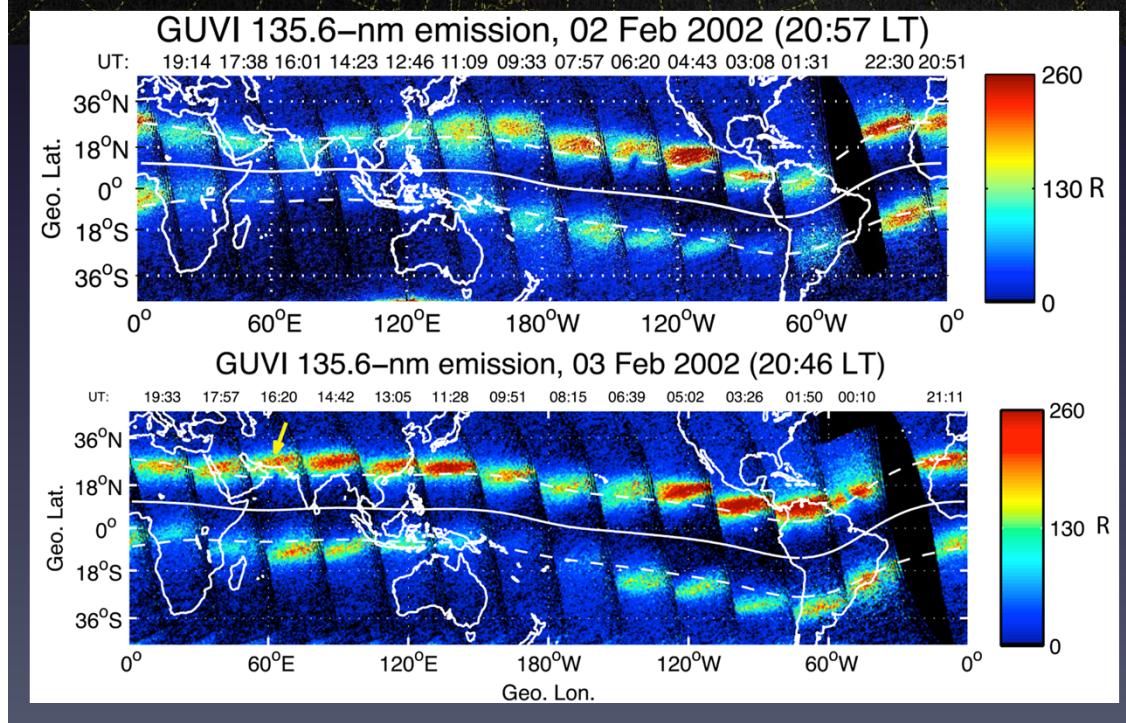
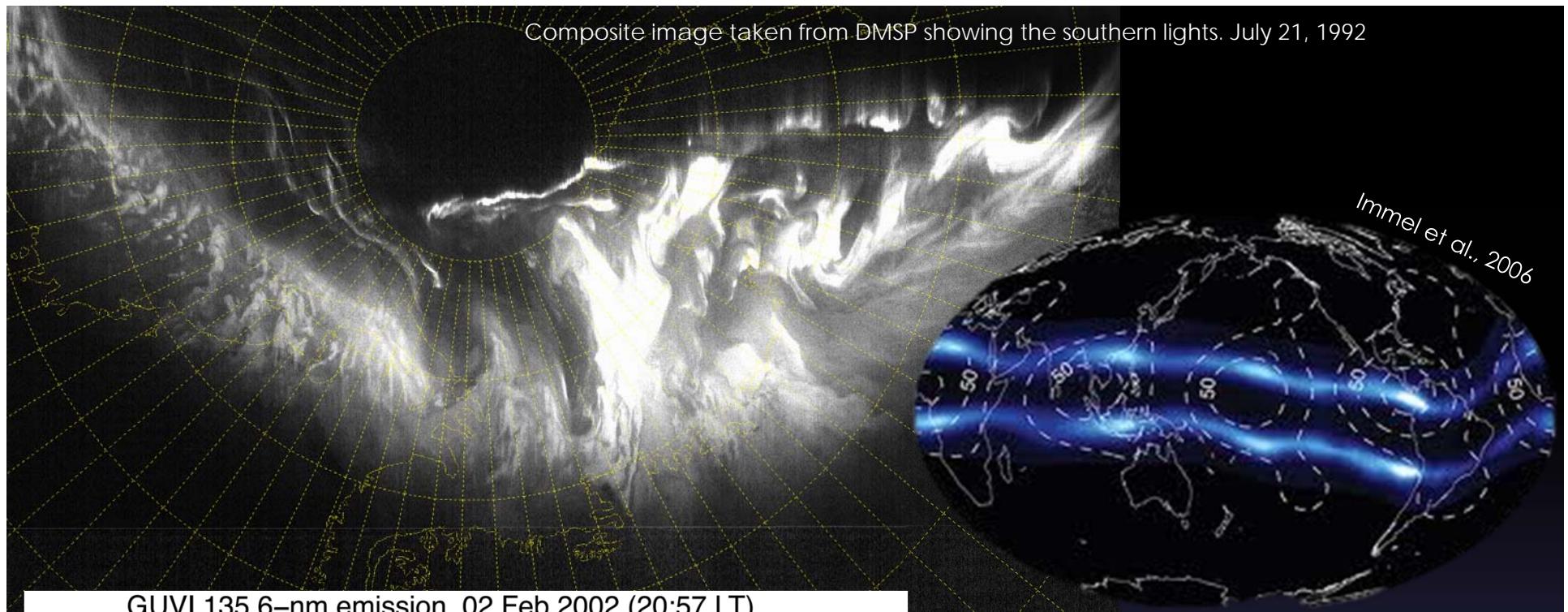
	Viking (UofC)	Freja (UofC)	IMAGE WIC	POLAR UVI	SPANN (SPIE)	UVAMC (2x2)	UVAMC (3x3)	GDO
	Previous Missions					Proposed Designs		
	Spinning Platform			Spin Stabilized				
FOV (°) degree	20 x 25	22.4 x 30	17.2	8	20	20	20	<b>3x3</b>
Image Shape	Rectangle	Rectangle	Circle	Circle	Circle	Circle	Circle	<b>Rectangle</b>
No of Pixels	288 x 385	228 x 385	256	228 x 200	512	512	341	<b>8Kx8K</b>
Number of Mirrors	2	2	2	3	4	4	4	<b>7</b>
Integration Period (s)	1.0	0.37	6.0	37	20	20	20	<b>1</b>
Image Cadence (s)	20	6.0	120	300	20	20	20	<b>1</b>
Apogee Height (km)	13,500	1,700	44,000	57,400	38,000	38,000	38,000	<b>255,000</b>
Global View	No	No	Yes	No	Yes	Yes	Yes	<b>Yes</b>
Nadir Resolution (km x km)	20.7 x 15.3	5.8 x 4.5	52	35 x 40	26	26	40	<b>&lt;2</b>
Input Aperture Area (cm <sup>2</sup> )	0.72*	1.6*	1.6	11.75	3.14	7.1	7.1	<b>36,615.5</b>
Photons/R at Image	0.059	0.082	0.79	0.79	0.98	2.22	4.99	<b>5.34</b>
Mass (kg)	2.0*	1.9	4.1	15	6	10	10	<b>2,000</b>
Visible Rejection	1.0	0.0009	0.0021	0.00042	0.0000044	0.0000044	0.0000044	<b>0.000004</b>
Sensitivity (Photons/sec/R at image)	0.06	0.22	0.13	0.02	0.05	0.11	0.25	<b>5.34</b>

\* Best estimates based on published information

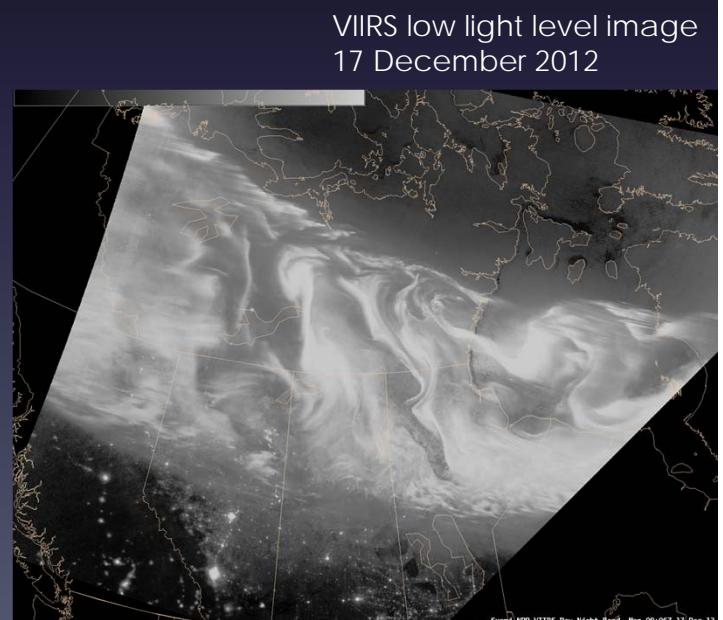
Most of content courtesy of Donovan, Spanswick and Cunick

# imaging the aurora





Basu et al., 2009



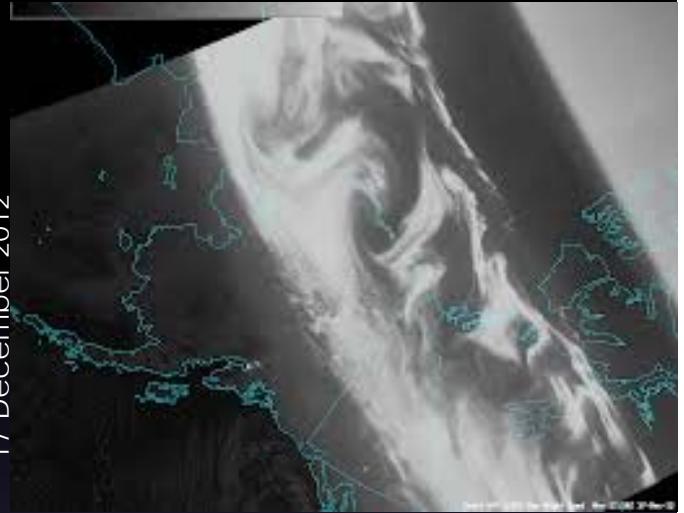
# disturbed conditions

Bastille Day Storm - IMAGE FUV WIC



2/14/14

VIIRS low light level image  
17 December 2012



THEMIS all-sky network  
9 March 2008



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# from the space station



GDO - a novel concept

ISS crew images from January/February 2012

# mission characteristics

- Nadir pointing with commanded pointing
  - Pointing resolution 0.5 km, knowledge 0.2 km
  - Pointing accuracy 0.1 arc sec
- Far UV < 200 nm
- Multiple sensors at focal plane (FUV, spectrograph)
- Large bandwidth (3.2 mbps, 11 terabits/day)
- Circular polar orbit of 60 Re – maximize time over earth high and mid latitudes

# telescope measurement characteristics

- Spatial resolution of < 2 km at nadir
- Integration time of 1 sec
- Sensitivity of 100 R with SNR=5 per pixel per 1 second image
- Full Earth disk image
- Wavelengths (nm): 135, 150, 170, 120-200 spectra



# summary

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*Observatory Class facility*

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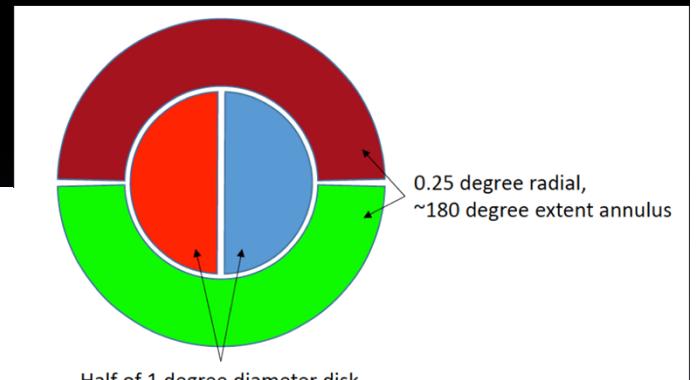
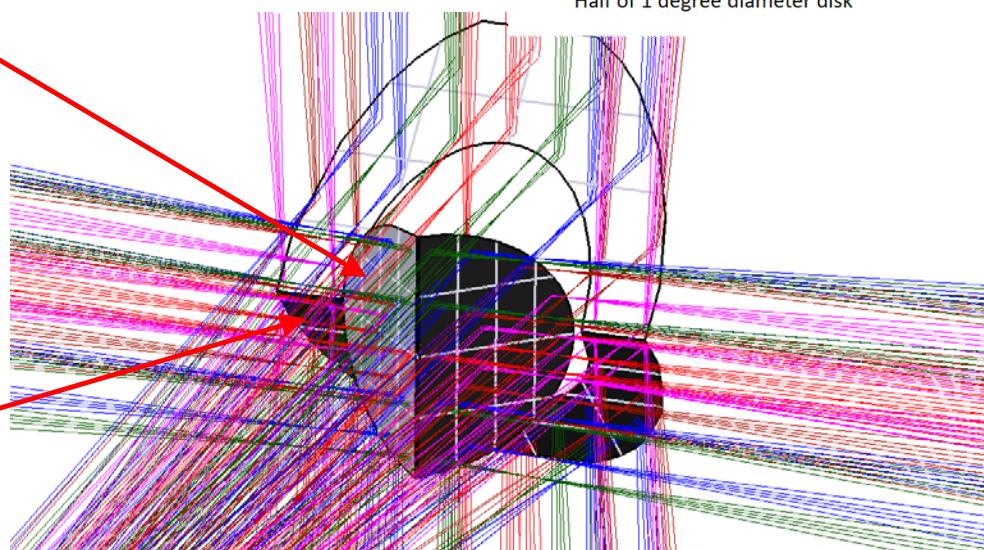
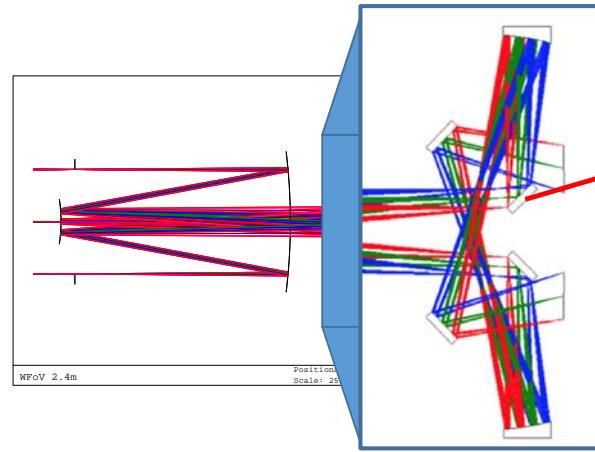
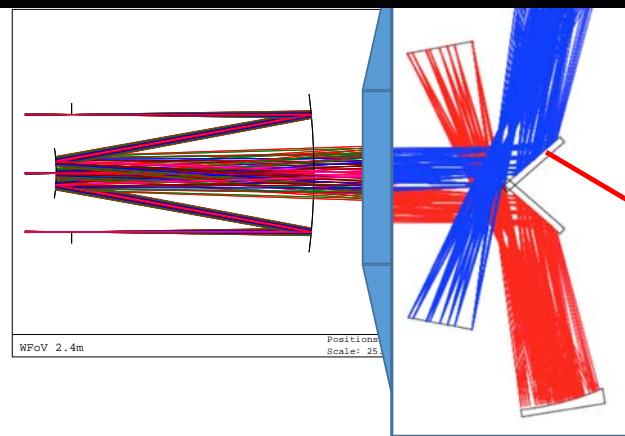


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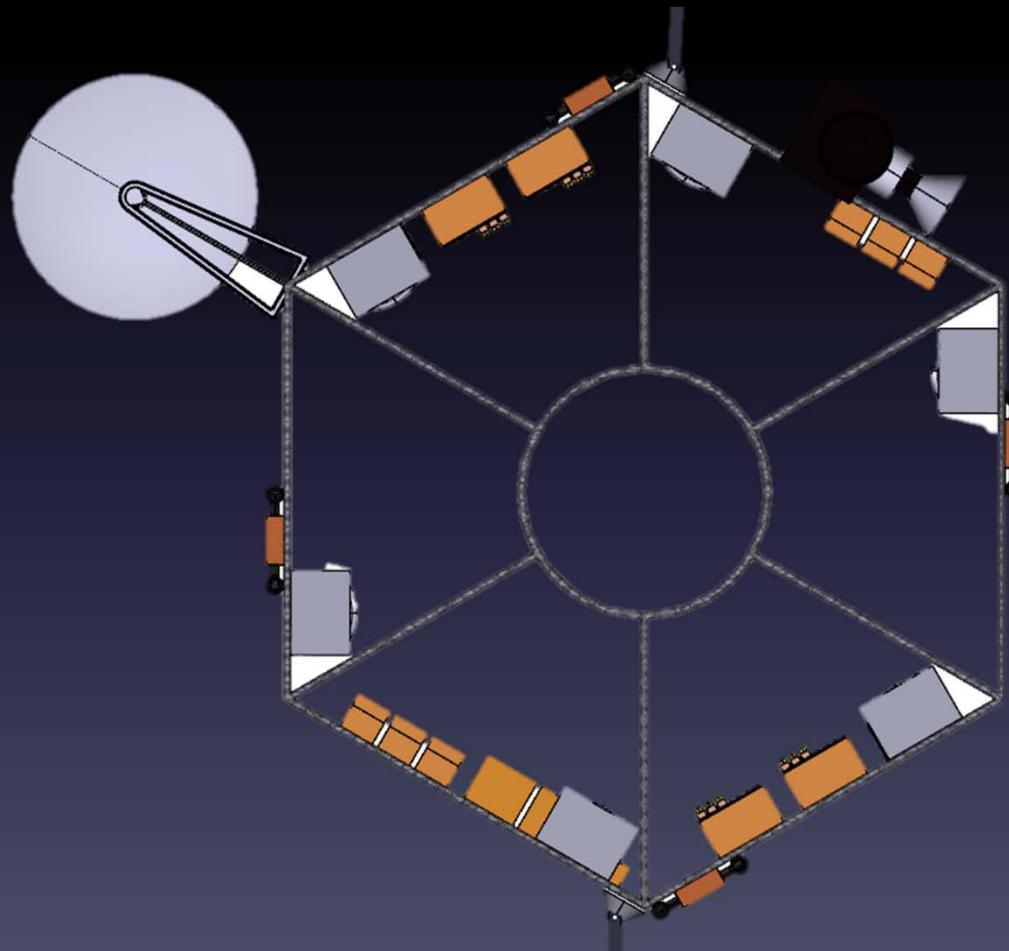
GDO - a novel concept

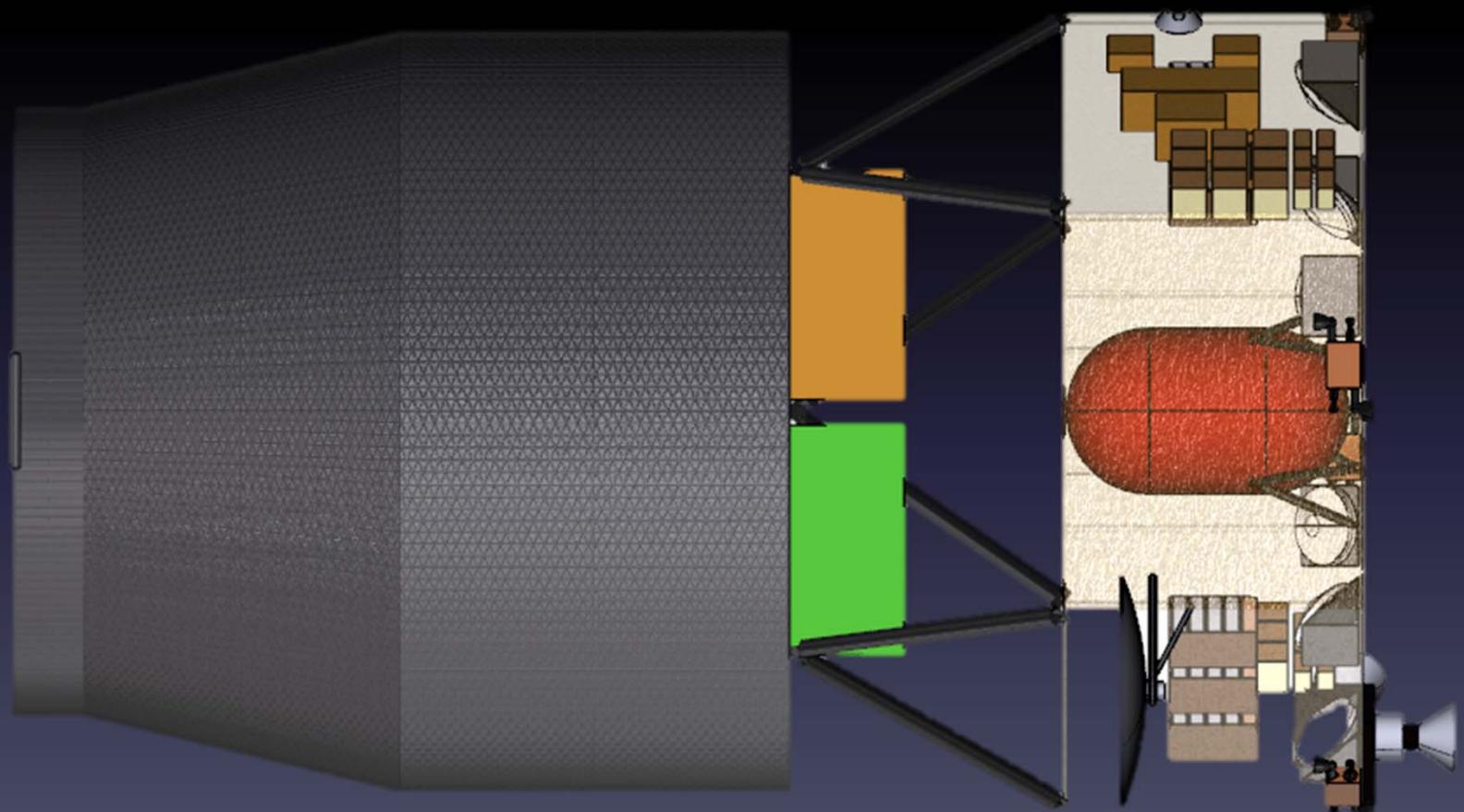
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# imager concept

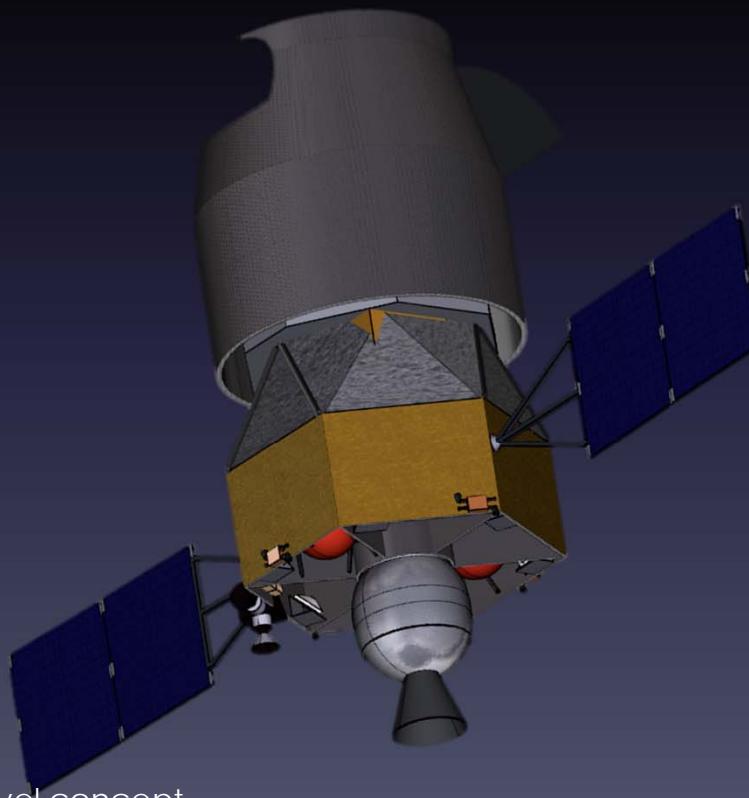


# spacecraft





# Atlas V 541 Star Motor



# technical challenges

- Solar blind sensors
  - Large arrays, four 4K sensor arrays
- Telemetry
  - Real time vs. full science data
- Thermal
  - LEO vs 60 Re

# unprecedented capabilities

- *GDO provides unprecedented improvement in signal to noise for global-scale imaging of the near-Earth space environment.*
  - GDO enables changes in the Earth's space environment to be resolved with orders of magnitude higher temporal and spatial resolution compared to existing data and other approaches.
- *GDO provides a new view of our planet.*
  - GDO continuously views the global-scale evolution while simultaneously capturing the changes at scales smaller than are possible with other methods. It has an unrivaled capability for resolving the temporal evolution, over many days, in local time or latitude.

# GDO provides the first . . .

- *Full near-Earth imagery of the storm and circulation systems of the upper atmosphere*
- *Observations of the ionosphere on a global and long-time scale basis with unprecedented resolution*
- *Probe of the mechanisms that control the evolution of planetary atmospheres*
- *Test of our understanding of how the Earth is connected to the Sun on a global scale*